August 2008

Species richness and abundance of dragonflies and damselflies (Odonata) at different elevations in Monteverde, Costa Rica

Christy Conley

Species richness and abundance of dragonflies and damselflies (Odonata) at different elevations in Monteverde, Costa Rica

Christy Conley

Department of Biology

ABSTRACT

Dragonflies and damselflies (Odonata) are very sensitive to differences in environmental conditions such as temperature, oxygen levels and amount of forest cover (Ramirez 2000). This study focuses on Odonata species in Monteverde, Costa Rica within the Lower Montane Wet habitat. I hypothesized that variations in altitude would influence Odonata biodiversity, abundance and species richness. I used a butterfly net to collect Odonata samples at five different elevations located at between altitudes of 1425 m and 1525 m. There was no significant correlation between altitude and species richness (r^2=0.3331; p=0.450185), H' (r^2=0.03221; p=0.188120), evenness (r^2=0.03221; p=0.188120), Odonata abundance (r^2=0.03221; p=0.188120) and *Brechmorhoga rapax* abundance (r^2=0.1099; p=0.872889). A significant positive correlation was found, however, between the abundance of *Cora chirripa* and altitude (r^2=0.3809; R=0.974679; N=5; p=0.004818). This may indicate that *Cora chirripa* is more sensitive to environmental factors determined by altitude than other Odonata species.

Resumen

Odonata son muy sensibles a diferencias en el medio ambiente. Este estudio investiga especies de Odonata en Monteverde, Costa Rica. Presumí que la diversidad, abundancia y número de especies de Odonata. Use un red de mariposas para obtener individuos del orden Odonata a cinco altitudes entre 1425 m and 1525 m. No hubo una correlación significativa entre altitud y el numéro de especies (r^2=0.3331; p=0.450185), H' (r^2=0.03221; p=0.188120), equidad (r^2=0.03221; p=0.188120), la abundancia de Odonata (r^2=0.03221; p=0.188120) y la abundancia de *Brechmorhoga rapax* (r^2=0.1099; p=0.872889). Existe una correlación significativa entre altitud y la abundancia de *Cora chirripa*. Este puede ser un indicio que *Cora chirripa* es más sensible a cambios en altitud que otros especies de Odonata.

INTRODUCTION

The order Odonata includes dragonflies and damselflies, aquatic insects that can be found around freshwater habitats. Odonates tend to be specialists and generally have narrow distributional ranges (Kalkman et al. 2007) Odonata larvae require very specific environmental conditions to survive. For example, they have a narrow range for temperature, oxygen levels, amount of forest cover, types of vegetation and water pollution. Some require very specific microhabitats such as leaves in riffles (Ramirez 2000). As a result, Odonata distribution is usually determined by the very specific conditions under which their larvae survive (Calvert 1908).

Altitude is an important factor when considering the ideal habitat for a given species. Increased altitude, for example, means decreased temperatures. This could affect odonates because, although some species of larger dragonflies and damselflies are able to thermoregulate to some extent, smaller odonates are unable to do so effectively. This inability is due to higher rates of convective heat loss in smaller odonates, as shown by May (1976) in a study on the suborder Anisoptera. Therefore, it might be harder for smaller odonates to maintain an effective body temperature at cooler temperatures, decreasing their range. Due to cool temperatures and other factors associated with higher altitudes, many odonates could have trouble surviving in such a habitat.

Because Odonata larvae have such narrow ranges, they are generally vulnerable to disturbance and require habitat preservation (Ramírez 2000). In order to protect Odonata biodiversity, therefore, it is important to understand the sorts of habitats in which a majority of Odonata species survive. Several studies have shown that Odonata diversity is greater at lower elevations. However, little research has been done on the order Odonata in the tropics in spite of the fact that more than half of the 4500 known species of Odonata can be found in this region (Hamilton et al. 1989). In particular, little research has been done on the distribution of Odonata in Cloud Forests, and little research has been done concerning Odonata along forest streams in general (Ramirez 2000).

This study focuses on Odonata in the Monteverde Cloud Forest. More specifically, I observed the effect of altitude on species richness and abundance of Odonata in forested streams in the Lower Montane Wet Forest. I also looked specifically at the effect of altitude on the abundance of the common damselfly species *Cora chirripa* and common dragonfly species *Brechmorhoga rapax*. I hypothesized that Odonata biodiversity, species richness and abundance would be influenced by altitude. I predicted that Odonata would display a greater abundance, biodiversity and species richness at lower altitudes than at higher altitudes.

METHODS

Study Sites

I conducted my study at the Quebrada Máquina, a freshwater stream located in the Lower Montane Wet region of Monteverde, Costa Rica. As measured at an attitude of 1460, this region receives 2519 mm of precipitation annually and has an average temperature of 18.5 degrees Celsius (Clark 2000).

I used an altimeter to select five points along the river at which I collected Odonata samples. Sampling sites were at elevations of 1425 m, 1505 m, 1510 m, 1525 m and 1535 m. For each site selected, I used a tape measure to mark a 20 meter stretch of river between which samples were collected, and I used stakes to indicate the boundaries.

Procedures

During trial 1, I began sampling at the site of highest elevation (1535 m) at 9:30 am. Here, I spent 30 minutes collecting dragonflies and damselflies with a butterfly net on both banks of the river, and I placed them in plastic containers in order to prevent re-collecting and re-counting the same individuals. When the thirty minutes was up, I recorded the number of captured individuals of each species. After recording data, I moved down the river to the next site at 1525 m and repeated the process. The second session started exactly a half hour after the end of the first session to allow time for recording data and for switching locations. I continued to move down the river and repeated the process at all elevations.

I kept one individual of each morphospecies and preserved it in a freezer so that it could later be identified. I used laminates to identify each species. If I could not identify a morphospecies with the laminates, I sent it to Eladio Cruz. The remaining Odonata were released after data collection.

Sampling occurred on July 27th, July 29th, July 30th, July 31st and August 2nd. I completed five trials, each on a different day. Each trial started at 9:30 am, and each day I started at a different elevation. For example, the first day I started at the site of 1535 m of elevation, the second day I started at the site of 1510 m of elevation, the third day I started at the site of 1525 m of elevation and so on. I always worked down the river, and once I reached the lowest elevation of 1425 m, I returned to the site of highest elevation (1535 m) and continued to work my way down until all five sites have been visited. As a result, each site was visited at 9:30, 10:30, 11:30, 12:30 and 1:30 over the course of the five days. This ensured that results were not affected by time of day.

I first determined species richness, H', evenness and abundance at each altitude. Then I used a Non-Parametric Spearman Correlation analysis to determine whether or not each of these variables had a relationship with altitude. I also determined the abundance of common damselfly species *Cora chirripa* and common dragonfly species *Brechmorhoga rapax*. I ran a Non-Parametric Spearman Correlation to determine the correlation between altitude and the abundance of both *Cora chirripa* and *Brechmorhoga rapax.*

RESULTS

Species collected included *Cora chirripa, Brechmorhoga rapax, Argia underwoodi, species 4, species 5, Hetaerina majuscala* and *Argia varaiabilis*.

Species richness, H', evenness and abundance of Odonata varied across different altitudes. Only two individuals and one species were found at 1425 m (Table 1). There was a non-significant positive correlation between altitude and species richness (Fig 1) and H' (Fig 2). There was a non-significant negative correlation between altitude and evenness (Fig 3). Finally, there was a non-significant positive correlation between altitude and Odonata abundance (Fig 4).

The two most common Odonata species were *Cora chirripa*, with a total of 21 individuals sampled, and *Brechmorhoga rapax,* with a total of 14 individuals sampled (Table 2). There was a significant positive correlation between altitude and abundance of *C. chirripa* (Fig 5). There was a non-significant positive correlation between altitude and abundance of *B. rapax*.

DISCUSSION

My results show no correlation between altitude and overall species richness, H', evenness or abundance. Also, I found no significant correlation between altitude and abundance of *B. rapax*. Such results do not support the hypothesis that species richness, biodiversity and abundance would be influenced by altitude. This could imply that the majority of Odonata species, including *Brechmorhoga rapax,* are not sensitive to small differences in altitude. Changes in temperature, dissolved oxygen content and any other environmental factor associated with altitude were probably too small to have a significant impact on odonate distribution. Therefore, future studies should test the effect of altitude over a larger range, as this might demonstrate a more significant correlation between altitude and species richness, biodiversity and abundance. My results could also be due to a small sample size or collection period. Were this study to be repeated, a larger sample size or longer collection period should be used.

The site at 1425 m showed unusually low abundance and species richness. This could be because it was located next to the Hotel Belmar, a source of disturbance. As Odonata do not respond well to disturbance (Ramirez 2000), the additional factor of disturbance may have skewed results. In order to control for additional factors such as disturbance, the same experiment should be conducted on a different river or at more sampling sites along the Quebrada Máquina.

I did find that *C. chirripa* was more common at higher altitudes. Such results could imply that *C. chirripa* is more sensitive to slight variations in altitude than other species of Odonata and tend to do better at higher elevations. For example, they could respond better to the higher oxygen levels found at the source of the river. As one study comparing abundance of Odonata in different rivers concluded, rivers with higher levels of dissolved oxygen tend to facilitate greater abundance of odonates than those with lower levels of dissolved oxygen (Salmah et al. 2006). *Cora Chirripa'*s greater abundance at higher altitudes, therefore, could be in response to higher oxygen levels found at river sources.

In order to protect this species, therefore, measures should be made to protect source habitats. For example, the addition of phosphorus or nitrogen into a system can increase eutrophication, thereby depleting dissolved oxygen within a water system (Carpenter et al. 1998). Such effects could be avoided by ensuring that increased soil or fertilizer runoff does not occur near the river sources.

AKNOWLEDGEMENTS

I would like to thank Tania Chavarría for overseeing my research. I would like to thank Karen Masters, Alan Masters, Pablo Allen Monge and José Carlos Calderón for additional assistance with my research. I would like to thank CIEE for providing me with the research materials. I would like to thank Eladio Cruz for helping me to identify Odonata species. Finally, I would like to thank the Estación Biológica de Monteverde for allowing me to conduct research on their property.

LITERATURE CITED

Carpenter, S.R., N.R. Caraco, D.L. Correll, R.W. Howarth, A.N. Sharpley and V.H. Smith. 1998. Nonpoint pollution of surface waters with phosphorus and nitrogen. Ecological Applications. 8(3): 559-568.

Clark, K. L., R. O. Lawton and P. R. Butler. "The Physical Environment" In: *Monteverde: Ecology and Conservation of a Tropical Cloud Forest*, Nalini M. Nadkarni and Nathaniel T. Wheelwright, eds. Oxford University Press, New York, NY, pp 15-38.

Hamilton, L. D. and R. D. Montgomerie. 1989. Population demography and sex ratio in a neotropical damselfly (Odonata: Coenagrionidae) in Costa Rica. Journal of Tropical Ecology. 5: 159-171.

Kalkman, V, V. Clausnitzer, K. Dijkstra, A. Orr, D. Paulson and J. Tol. 2007. Global diversity of dragonflies (Odonata) in freshwater. Hydrobiologia. 595: 351-363.

May, M. L. 1976. Thermoregulation and adaptation to temperature in dragonflies (Odonata Anisoptera). Ecological Monographs. 46: 1-32.

Calvert, P. P. 1908. The composition and ecological relations of the Odonate fauna of Mexico and Central America. Proceedings of the Academy of Natural Sciences of Philadelphia. 60(3): 460-491.

Ramírez, A. 2000. "Dragonflies and Damselflies of Costa Rican Cloud Forests" In: *Monteverde: Ecology and Conservation of a Tropical Cloud Forest*, Nalini M. Nadkarni and Nathaniel T. Wheelwright, eds. Oxford University Press, New York, NY, pp 97.

Salmah, M.D., R. Che, S. W. Tribuana and A. A. Hassan. 2006. The population of Odonata (dragonflies) in small tropical rivers with reference to asynchronous growth patterns. Aquatic Insects. 28: 195-209.

Table 1. Species richness, H’, evenness and abundance of Odonata varied with altitude.

Site	Altitude	S	H	E	# abundance
1	1425	1	0.25	1	2
2	1505	3	0.64	0.58	5
3	1510	6	1.7	0.95	23
4	1525	3	0.76	0.69	7
5	1535	3	0.58	0.53	17

Table 2. The abundance of *Cora chirripa* and *Brechmorhoga rapax* differed with altitude.

Altitude	1505	1510	1525	1535
Species 1	0	3	4	14
Species 2	3	8	2	1

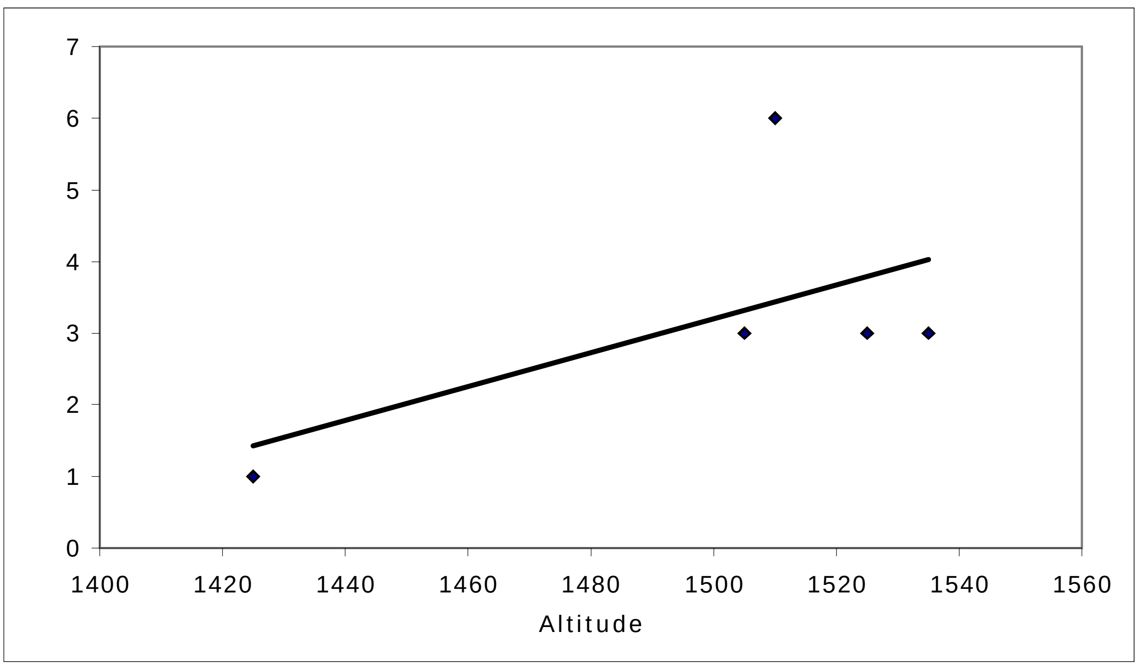

Figure 1. Relationship between Odonata species richness and altitude. I did not find a significant relationship ($r^2=0.3331$; $p=0.450185$).

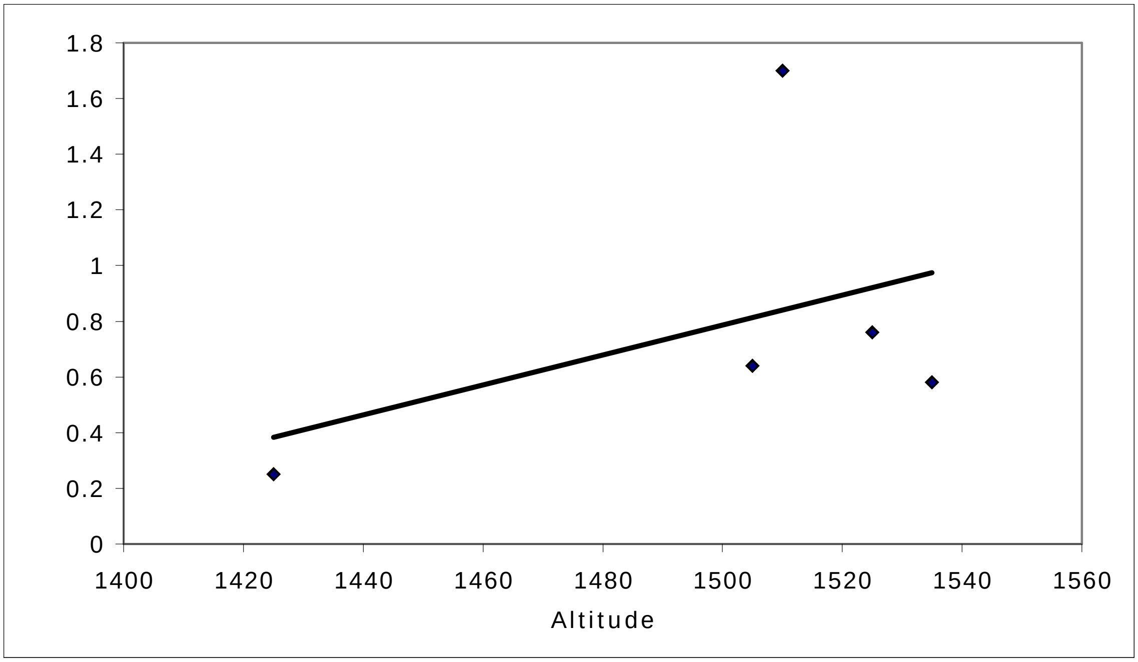

Figure 2. Relationship between H' and altitude. I did not find a significant relationship (r^2=0.1841; p=0.62).

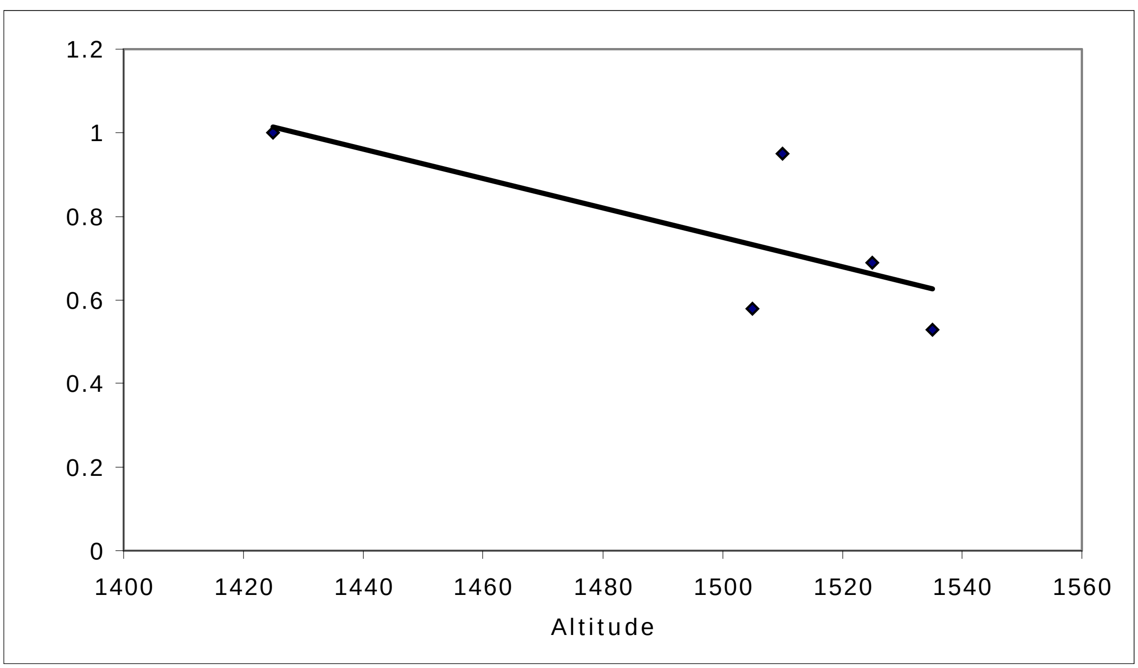

Figure 3. Relationship between Odonata evenness and altitude. I did not find a significant relationship (r^2=0.5153; p=0.188120).

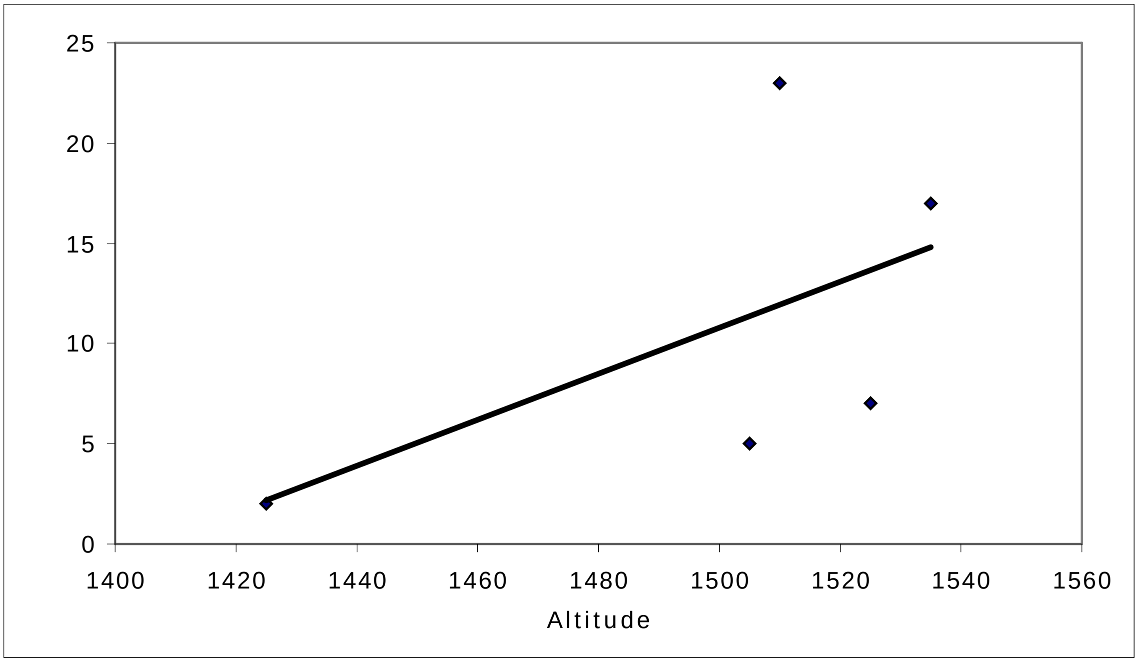

Figure 4. Relationship between Odonata abundance and altitude. I did not find a significant relationship ($r^2=0.03221$; $p=0.188120$).

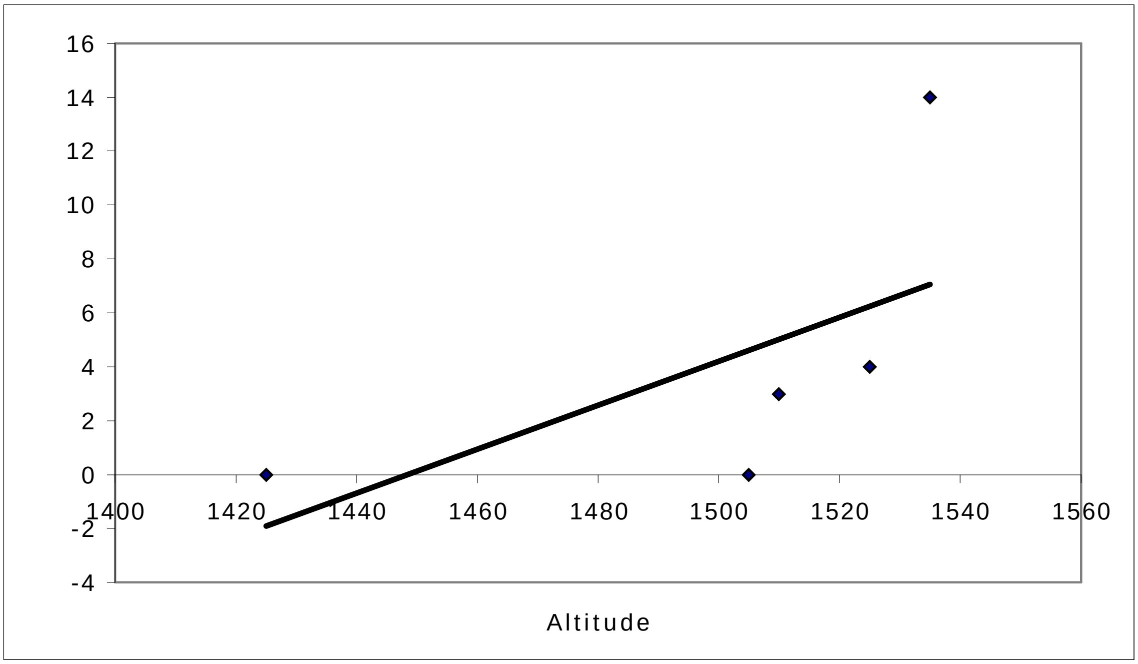

Figure 5. Relationship between the abundance of *Cora chirripa* and altitude. I did find a significant relationship (r^2=0.3809; R=0.974679; N=5; p=0.004818).

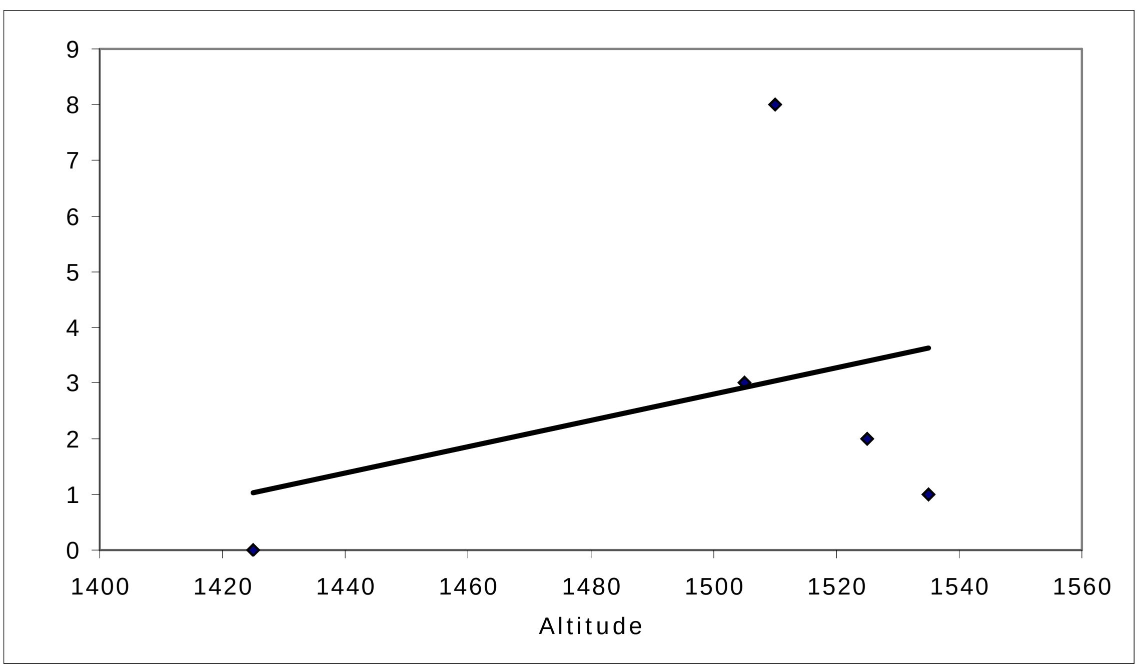

Figure 6. Relationship between altitude and the abundance of *Brechmorhoga rapax*. I did not find a significant relationship (r^2=0.1099; p=0.872889).